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CRUISE REPORT

VESSEL: *Townsend Cromwell*, Cruise 99-05 (TC-243)

**CRUISE
PERIOD:** 26 April-9 May 1999

**AREA OF
OPERATION:** Waters in the vicinity of the Subtropical Front north of the Hawaiian Archipelago and to the southwest of Niihau Island (Fig. 1).

**TYPE OF
OPERATION:** Personnel from the Southwest Fisheries Science Center (SWFSC) Honolulu Laboratory (HL) and the University of Hawaii Department of Oceanography (UH) conducted a series of conductivity-temperature-depth (CTD) casts and discrete depth water sampling for extracted chlorophyll and nutrient determinations along meridional transects to support ongoing studies characterizing the physical and biological oceanographic properties associated with the Subtropical Front. Exploratory hydrographic surveys were also made along transects intersecting the site of a proposed oceanographic mooring deployment. Estimates of in situ ocean currents' direction and velocities obtained along the cruise track with an acoustic Doppler current profiler (ADCP) and underway measurements of sea surface temperature and salinity with a hull-mounted thermosalinograph (TSG) were also used to help conduct the near real time synoptic assessment of the prevailing oceanography.

ITINERARY:

26 April - Departed Snug Harbor, Honolulu, at 1800 and proceeded to first scheduled CTD station at Station ALOHA, site of the Hawaiian Ocean Time Series (HOT) Study at lat. 22°45'N, long. 158°00'W. On board Robert R. Bidigare, Stephanie Christensen, Gary L. Dewey, Evan Howell, Russell

Price, Victoria Rechtenwald, Michael P. Seki and Marian Westley.

- 27 April - Arrived at lat. 22°45'N, long. 158°00'W. Commenced conducting a series of 500 m CTD casts spaced 15 nmi apart (0.25° longitude). Continued sampling strategy northward along the 158°W meridian.
- 1 May - Arrived at lat. 33°N, long. 158°W completing the northernmost scheduled CTD cast and hydrographic transect. Departed for the first scheduled station of the BIGEYE mooring site survey at 21°17'N, 161°54'W.
- 5 May - Arrived at 21°17'N, 161°54'W and resumed hydrographic operations with CTD casts spaced about 16 nmi apart along transects corresponding to the TOPEX satellite orbit path.
- 7 May - Completed operations at last scheduled station on transect. Proceeded to Snug Harbor.
- 9 May - Arrived Snug Harbor, Honolulu. Disembarked Bidigare, Christensen, Dewey, Howell, Price, Rechtenwald, Seki, and Westley. End of cruise.

MISSIONS AND RESULTS:

- A. Describe the oceanographic features characterizing the Subtropical Frontal region through CTD casts and continuous ADCP and TSG measurements.

A total of 42 CTD casts were conducted with a SBE 9/11+ CTD system along a single discrete sampling transect. These data together with continuous observations obtained from the ship-mounted ADCP and TSG were used to characterize hydrographic conditions through the water column associated with the Subtropical Frontal Zone and the mesoscale dynamics that characterize the region.

The Winter Front (WF) typically associated with commercial swordfish fishing activity was positioned at lat. 31.5°N, more than 200 nmi farther north than found the prior year along the same line and at any time during the 4 years of surveys (Fig. 2). Depression (and uplifting) of isotherms, isohalines and isopycnals corresponding to the convergence (and divergence) associated with the front is depicted in the vertical sections (i.e., with respect to depth) of the sampled parameters along the trackline. Moderately weak horizontal surface gradients across the front measured: $\Delta T \approx 2^\circ\text{C} \cdot 50 \text{ km}^{-1}$, $\Delta S \approx 0.5 \text{ PSU} \cdot 50 \text{ km}^{-1}$, and $\Delta \sigma_t \approx 0.2 \cdot 50 \text{ km}^{-1}$.

- B. Assess the influence of the physical dynamics associated with the frontal region on biological productivity through CTD mounted fluorometer measurements and discrete depth water samples with Niskin bottles for extracted phytoplankton and nutrients assessment.

In situ total chlorophyll was estimated with CTD mounted fluorometer measurements at all 42 CTD stations. In addition, water samples from discrete depths were collected for determination of extracted chlorophyll (fluorescence), pigments (high performance liquid chromatography, HPLC) and unfiltered nutrients concentrations. For discrete depth-extracted phytoplankton analyses, seawater was acquired from depths of 200 m, 150 m, 125 m, 100 m, 80 m, 65 m, 50 m, 35 m, 20 m, and at the surface. Water samples of volumes 1-L for fluorescence and 2-L for HPLC were vacuum filtered through 47 mm diameter, 0.7 μm Gelman TCLP glass fiber filters. Measurements of fluorescence to yield total chlorophyll, chl-a, and phaeophytin concentration were made at sea on a Turner 10-AU fluorometer after 24-h extraction in acetone. Filters containing pigments for HPLC were frozen in liquid nitrogen and returned to the University of Hawaii for later analysis. Unfiltered water samples (120 ml) for nutrients (nitrate + nitrite, phosphate and silicate) determinations were collected at 500 m, 300 m, 150 m, 125 m, 100 m, 80 m, 65 m, 50 m, 35 m and at the surface; all samples were frozen and returned to the HL for analysis.

Preliminary analysis reveal enhanced chlorophyll concentrations occurring primarily at the subsurface deep chlorophyll maximum (DCM) in the region adjacent to the cold side of the front coincident with shoaling of isotherms and isopycnals (e.g., Fig. 2d); although the chlorophyll concentrations in the DCM were by comparison, substantially lower (about half) than 1998 levels. Observed patterns are consistent with that expected with input of nutrients into the euphotic surface waters with upwelled water and the advection and accumulation of phytoplankton at adjacent frontal convergences. Consistent with satellite information provided by Hawaii Coastwatch, the Subtropical Front and associated surface chlorophyll front had already undergone rapid migration to the north and were never encountered on the cruise.

- C. Obtain baseline hydrographic and bathymetric information in the vicinity of the proposed "BIGEYE" oceanographic mooring deployment at lat. 20°36.0'N, long. 161°34.2'W.

Two 270 nmi (180 km) long hydrographic/bathymetric transects (corresponding to the TOPEX satellite ascending and descending orbital passes) were conducted in anticipation of the mooring deployment scheduled for December 1999. Topography at the targeted site was confirmed flat in 4,680

m (ca. 2,496 fathoms) of water with along-track information acquired with a 12 kHz echosounder. Fourteen CTD casts were made during the BIGEYE survey; homogeneity of the vertical structure around the mooring site confirmed the absence of mesoscale perturbation revealed by coincident satellite altimetry and sea surface temperature (Fig. 3).

SCIENTIFIC**PERSONNEL:**

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Figure 1.--Cruise track of *Townsend Cromwell* cruise 99-05 (TC-243), 26 April-9 May 1999. (BIGEYE-1 = proposed mooring site at lat. 20°36.0'N, long. 161°34.2'W).